

Example 8: Mercury's Year = 88 Earth days and its distance from the Sun is 0.37 AU. Find the orbital radius of Venus if its year = 224.7 Earth days.

To derive Kepler's Constant, use

$F_c = F_g$ for orbiting planets

$$\frac{4\pi^2 r}{T^2} = \frac{GM}{r^2} \Rightarrow \text{rearrange to}$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2} \leftarrow \begin{array}{l} \text{central mass} \\ \text{is constant} \end{array}$$

$$\text{so } \frac{r^3}{T^2} = k \quad (\text{a constant for any units of } r \text{ \& } T)$$

$$\Rightarrow \text{for Mercury: } \frac{(0.37)^3}{(88)^2} = 6.54 \times 10^{-6}$$

$$\Rightarrow \text{for Venus: } \frac{r^3}{(224.7)^2} = 6.54 \times 10^{-6}$$

$$\boxed{r = 0.69 \text{ AU's}}$$